JC20 Rec'd PCT/PTO 28 MAR 2002 10/089237

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

REQUEST FOR FILING NATIONAL PHASE OF PCT APPLICATION UNDER 35 U.S.C. 371 AND 37 CFR 1.494 OR 1.495

To: Hon. Commissioner of Patents
Washington, D.C. 20231

00909

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US)

Atty Dkt: P 291112 /P232USPC
M# /Client Ref.

From: Pillsbury Winthrop LLP, IP Group:

Date: March 28, 2002

This is a **REQUEST** for **FILING** a PCT/USA National Phase Application based on:

1. International Application	2. International Filing Date	3. Earliest Priority Date Claimed
PCT/IS00/00010	02 October 2000	01 October 1999
⇧ country code	Day MONTH Year	Day MONTH Year (use item 2 if no earlier priority)

4. Measured from the earliest priority date in item 3, this PCT/USA National Phase Application Request is being filed within:

(a) ☐ 20 months from above item 3 date (b) ☒ 30 months from above item 3 date,

(c) Therefore, the due date (unextendable) is April 1, 2002

5. Title of Invention MULTI-FILTER

6. Inventor(s) VILHJALMSSON, Jon Reynir
OLAFSSON, Jon Thor

Applicant herewith submits the following under 35 U.S.C. 371 to effect filing:

7. ☒ Please immediately start national examination procedures (35 U.S.C. 371 (f)).

8. ☒ **A copy of the International Application** as filed (35 U.S.C. 371(c)(2)) is transmitted herewith (file if in English but, if in foreign language, file only if not transmitted to PTO by the International Bureau) including:

a. ☐ Request;
b. ☒ Abstract;
c. 14 pgs. Spec. and Claims;
d. 2 sheet(s) Drawing which are ☐ informal ☒ formal of size ☒ A4 ☐ 11"

9. ☒ **A copy of the International Application has been transmitted by the International Bureau.**

10. **A translation of the International Application** into English (35 U.S.C. 371(c)(2))
a. ☐ is transmitted herewith including: (1) ☐ Request; (2) ☐ Abstract;
(3) _____ pgs. Spec. and Claims;
(4) _____ sheet(s) Drawing which are:
☐ informal ☐ formal of size ☐ A4 ☐ 11"
b. ☒ is not required, as the application was filed in English.
c. ☐ is not herewith, but will be filed when required by the forthcoming PTO Missing Requirements Notice per Rule 494(c) if box 4(a) is X'd or Rule 495(c) if box 4(b) is X'd.
d. ☐ Translation verification attached (not required now).

RE: USA National Phase Filing of PCT /IS00/00010

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11. ☒ Please see the attached Preliminary Amendment

12. ☐ Amendments to the claims of the International Application **under PCT Article 19 (35 U.S.C. 371(c)(3)), i.e., before 18th month from first priority date above in item 3, are transmitted herewith (file only if in English) including:**

13. ☒ PCT Article 19 claim amendments (if any) have been transmitted by the International Bureau

14. ☐ Translation of the amendments to the claims **under PCT Article 19 (35 U.S.C. 371(c)(3)), i.e., of claim amendments** made before 18th month, **is attached (required by 20th month from the date in item 3 if box 4(a) above is X'd, or 30th month if box 4(b) is X'd, or else amendments will be considered canceled).**

15. **A declaration of the inventor** (35 U.S.C. 371(c)(4))
a. ☐ is submitted herewith ☐ Original ☐ Facsimile/Copy
b. ☒ is not herewith, but will be filed when required by the forthcoming PTO Missing Requirements Notice per Rule 494(c) if box 4(a) is X'd or Rule 495(c) if box 4(b) is X'd.

16. **An International Search Report (ISR):**
a. Was prepared by ☒ European Patent Office ☐ Japanese Patent Office ☐ Other
b. ☒ Has been transmitted by the international Bureau to PTO.
c. ☒ Copy herewith (3 pg(s).) ☐ plus Annex of family members (__ pg(s).).

17. **International Preliminary Examination Report** (IPER):
a. ☒ has been transmitted (if this letter is filed after 28 months from date in item 3) in English by the International Bureau with Annexes (if any) in original language.
b. ☒ copy herewith in English.
c.1 ☐ IPER Annex(es) in original language ("Annexes" are amendments made to claims/spec/drawings during Examination) including attached amended:
c.2 ☐ Specification/claim pages #__ claims #
Dwg Sheets #
d. ☐ Translation of Annex(es) to IPER **(required by 30th month due date, or else annexed amendments will be considered canceled).**

18. **Information Disclosure Statement** including:
a. ☒ Attached Form PTO-1449 listing documents
b. ☐ Attached copies of documents listed on Form PTO-1449
c. ☒ A concise explanation of relevance of ISR references is given in the ISR.

19. ☐ **Assignment** document and Cover Sheet for recording are attached. Please mail the recorded assignment document back to the person whose signature, name and address appear at the end of this letter.

20. ☐ Copy of Power to IA agent.

21. ☐ **Drawings** (complete only if 8d or 10a(4) not completed): __ sheet(s) per set: ☐ 1 set informal; ☐ Formal of size ☐ A4 ☐ 11"

22. Small Entity Status ☒ is **Not** claimed ☐ is claimed (**pre**-filing confirmation required)
22(a) __ (No.) Small Entity Statement(s) enclosed (since 9/8/00 Small Entity Statements(s) not essential to make claim)

23. **Priority** is hereby claimed under 35 U.S.C. 119/365 based on the priority claim and the certified copy, both filed in the International Application during the international stage based on the filing in (country) ICELAND of:

	Application No.	Filing Date		Application No.	Filing Date
(1)	5207	01 October 1999	(2)		
(3)			(4)		
(5)			(6)		

a. ☒ See Form PCT/IB/304 sent to US/DO with copy of priority documents. If copy has not been received, please proceed promptly to obtain same from the IB.
b. ☒ Copy of Form PCT/IB/304 attached.

RE: USA National Phase Filing of PCT/IS00/00010

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24. Attached: Copy of the Written Opinion and Response

25 Per Item 17.c2, **cancel original** pages #___, claims #___, Drawing Sheets #

26. **Calculation of the U.S. National Fee (35 U.S.C. 371 (c)(1)) and other fees is as follows:**
Based on amended claim(s) per above item(s) ☐ 12, ☐ 14, ☐ 17, ☐ 25 (hilite)

Total Effective Claims	19	minus 20 =	0	x $18/$9 =	$0	966/967
Independent Claims	1	minus 3 =	0	x $84/$42 =	$0	964/965
If any proper (ignore improper) Multiple Dependent claim is present,				add$280/$140	+280	968/969

BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(4)): →→ **BASIC FEE REQUIRED, NOW** →→→→

A. If country code letters in item 1 are **not** "US","BR","BB","TT","MX","IL" "NZ", "IN", "ZA", "LC" or "PH"

See item 16 re:

1. Search Report was not prepared by EPO or JPO ---------- add$1,040/$520 960/961
2. Search Report was prepared by EPO or JPO ---------- add$890/$445 +890 970/971

SKIP B, C, D AND E UNLESS country code letters in item 1 are "US","BR","BB","TT","MX","IL", "NZ", "IN", "ZA", "LC" or "PH"

(X) → ☐ B. If USPTO did not issue both International Search Report (ISR) and (if box 4(b) above is X'd) the International Examination Report (IPER), ---------- add$1,040/$520 +0 960/961

(only) (one) → ☐ C. If USPTO issued ISR but not IPER (or box 4(a) above is X'd), (of) ---------- add$740/$370 +0 958/959

(these) (4) → ☐ D. If USPTO issued IPER but IPER Sec. V boxes not all 3 (boxes) YES, ---------- add$710/$355 +0 956/957

→ ☐ E. If international preliminary examination fee was paid to USPTO and Rules 492(a)(4) and 496(b) satisfied (i.e., in IPER Sec. V all 3 boxes must be YES for all claims), -- add $100/$50 +0 962/963

27. **SUBTOTAL =** $1170

28. If Assignment box 19 above is X'd, add Assignment Recording fee of ----$40 +0 (581)

29. If box 15a is x'd, determine whether inventorship on Declaration is different than in international stage. If yes, add (per Rule 497(d) ----$130 +0 (098)

30. Attached is a check to cover the ---------- **TOTAL FEES** $1170

Our Deposit Account No. 03-3975
Our Order No. 81691 (C#) | 291112 (M#)

00909

CHARGE STATEMENT: The Commissioner is hereby authorized to charge any fee specifically authorized hereafter, or any missing or insufficient fee(s) filed, or asserted to be filed, or which should have been filed herewith or concerning any paper filed hereafter, and which may be required under Rules 16-18 and 492 (missing or insufficient fee only) now or hereafter relative to this application and the resulting Official document under Rule 20, or credit any overpayment, to our Account/Order Nos. shown above for which purpose a duplicate copy of this sheet is attached.
This CHARGE STATEMENT does not authorize charge of the issue fee until/unless an issue fee transmittal form is filed

Pillsbury Winthrop LLP
Intellectual Property Group

By Atty: Jack S. Barufka **Reg. No.** 37087

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Atty/Sec: JSB/rsp

NOTE: File in duplicate with 2 postcard receipts (PAT-103) & attachments.

#5
DT17 Rec'd PCT/PTO 04 DEC 2002

10/089237

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re PATENT APPLICATION of

VILHJALMSSON et al.

Application No. 10/089,237 Group Art Unit: Unknown

Filed: March 28, 2002 Examiner: Unknown

For: MULTI-FILTER

* * * * *

December 4, 2002

PRELIMINARY AMENDMENT

Hon. Commissioner of Patents
and Trademarks
Washington, D.C. 20231

Sir:

Prior to the initial examination of the above-identified application, kindly amend as follows:

IN THE CLAIMS:

Please amend claims 3-8, 10-11 and 15-17 as follows:

3. (Amended) A method according to claim 1, wherein the processing comprises calculating an average value of N last provided data of the stream of data.

4. (Amended) A method according to claim 1, wherein each of the at least two different processing means processes an average value of a number of last provided data of the stream of data N and wherein N is a different number for each of the processing means.

5. (Amended) A method according to claim 1, wherein the stability requirement to be fulfilled comprises comparing an output signal of one of the at least two processing means with a reference value.

6. (Amended) A method according to claim 1, wherein the stability requirement to be fulfilled comprises a requirement to a maximum difference between two successive output signals of one of the at least two processing means.

7. (Amended) A method according to claim 1, wherein a first set of data comprising a number N of data from the stream of data is processed by one of the at least two different processing means and wherein the remaining processing means are processing sub-sets of the first set of data.

8. (Amended) A method according to claim 1, wherein the first signal is an electrical current provided by an instrument.

10. (Amended) A method according to claim 1, wherein the first signal is representing responses to weighing of an item on a weighing scale.

11. (Amended) A method according to claim 1, wherein the processing means comprises) digital filters for filtering the stream of data.

15. (Amended) A method according to claim 14, wherein the running averaging algorithms are applied successively; the next algorithm applied is applied based at least partly on the result of the previously applied algorithm.

16. (Amended) A method according to claim 1, wherein an output signal from the last one of the at least two different processing means is being

assigned to the measure in case no output signal fulfils the stability requirement.

17. (Amended) A method according to claim 1, wherein an output signal from a processing means with a medium processing speed is being assigned to the measure in case no output signal fulfils the stability requirement.

REMARKS

By this Preliminary Amendment the claims have been amended to remove multiple claim dependencies. No new matter has been added.

Prompt and favorable examination on the merits is earnestly solicited.

Attached is a marked-up version of the changes made to the claims by the current amendment. The attached Appendix is captioned **"Version with markings to show changes made"**.

Respectfully submitted,

PILLSBURY WINTHROP LLP

By: _____

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APPENDIX

Version with Markings to Show Changes Made

In the Claims:

Claims 3-8, 10-11 and 15-17 were amended as follows:

3. (Amended) A method according to claim 1 [or 2], wherein the processing comprises calculating an average value of N last provided data of the stream of data.

4. (Amended) A method according to claim 1 [any of the preceding claims], wherein each of the at least two different processing means processes an average value of a number of last provided data of the stream of data N and wherein N is a different number for each of the processing means.

5. (Amended) A method according to claim 1 [any of the preceding claims], wherein the stability requirement to be fulfilled comprises comparing an output signal of one of the at least two processing means with a reference value.

6. (Amended) A method according to claim 1 [any of the preceding claims], wherein the stability requirement to be fulfilled comprises a requirement to a maximum difference between two successive output signals of one of the at least two processing means.

7. (Amended) A method according to claim 1 [any of the preceding claims], wherein a first set of data comprising a number N of data from the stream of data is processed by one of the at least two different

processing means and wherein the remaining processing means are processing sub-sets of the first set of data.

8. (Amended) A method according to claim 1 [any of the preceding claims], wherein the first signal is an electrical current provided by an instrument.

10. (Amended) A method according to claim 1 [any of the preceding claims], wherein the first signal is representing responses to weighing of an item on a weighing scale.

11. (Amended) A method according to claim 1 [any of the preceding claims], wherein the processing means comprises) digital filters for filtering the stream of data.

15. (Amended) A method according to claim [13 or] 14, wherein the running averaging algorithms are applied successively; the next algorithm applied is applied based at least partly on the result of the previously applied algorithm.

16. (Amended) A method according to claim 1 [any of the preceding claims], wherein an output signal from the last one of the at least two different processing means is being assigned to the measure in case no output signal fulfils the stability requirement.

17. (Amended) A method according to claim 1 [any of the preceding claims], wherein an output signal from a processing means with a medium processing speed is being assigned to the measure in case no output signal fulfils the stability requirement.

JC13 Rec'd PCT/PTO 28 MAR 2002

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re PATENT APPLICATION OF

Inventor(s): VILHJALMSSON et al.

Filed: Herewith

Title: MULTI-FILTER

March 28, 2002

PRELIMINARY AMENDMENT

Hon. Commissioner of Patents
Washington, D.C. 20231

Sir:

Please amend this application as follows:

IN THE SPECIFICATION:

At the top of the first page, just under the title, insert

☒ --This application is the National Phase of International Application PCT/IS00/00010 filed 2 October 2000 which designated the U.S. and that International Application ☒ was ☐ was not published under PCT Article 21(2) in English.--

Respectfully submitted,

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MULTI-FILTER

Field of the Invention

The present invention relates to a method for weighing items and in particular to a method of filtering signals representing the weight of an item.

The invention is applicable in all measuring instruments which indicate an average value calculated from a signal which also has unwanted frequency components of one or more unknown frequencies.

This is, for example, the case in voltmeters, ampere meters and weighing-scales. Normally, the indicated result is the average value of the signal measured for a much longer time than the expected period of the slowest frequency component. This method is well known and reliable, but has the drawback of being very slow in situations where measuring speed is of importance.

The invention is of particular importance in high speed weighing scales. In that case, the average value is the result (the weight) but because of vibrations in the mechanics of the scale and its base, a lot of unwanted frequency components are added to the measured value.

Description of the Prior Art

Electronic scales comprising a load cell providing readout in terms of voltage representing the weight of the item today perform weighing of items. This readout is typically passed through an analogue to digital (A/D) converter that converts the electrical signal to a digital signal normally represented by a bit representation of a number. This bit representation is then manipulated further in order to provide an readout of the weight of the item on display.

When an item is to be weighed by such an electronic scale - or in general by an ordinary scale - the item is arranged on a scale platform. As the mechanical parts of the scale are not weightless the scale platform and the parts connected to the platform may be able to vibrate which in turn influences the readout - the measurement - of the scale. The

vibration may in general be induced by at least two measures: the way the item is arranged on the scale platform and the vibrations of the surroundings.

The first measure may for instance be instanced by dropping an item on to the scale platform - a situation, which for instance occur in a process line in which items are being conveyed from a processing station past a weighing station to a grading and/or packing station.

The second measure may for instance be instanced when the scale is applied in an environment in which heavy machinery inducing vibrations is present.

In both cases, or of course in combinations of these, the signal of from the load cell and in turn the readout of the weight will follow a curve which ideally can be described as the motion of a damped oscillation, where the average value of curve is the final steady state value, i.e. the weight which is to be determined.
In weighing scales there are mostly 3 types of unwanted frequency components. These occur due to:

1 Steady vibrations in the base of the scale from nearby machinery.
2 Vibrations which occur when an object is placed on the platform. These vibrations cease when the mechanism becomes stable.
3 Short-duration mechanical transients which hit the base of the scale.

Every scale designer wants to make a fast scale, which displays the correct result as soon as an object is placed on the platform. A faster scale saves both time and money. At the same time, he wants the scale to be insensitive to vibrations and shocks that strike the platform or the base of the scale. Unfortunately, it is difficult to achieve both features at the same time using only one filter.

If a fast low pass filter is used - with a high cut-off frequency, the scale will be fast, but vibrations and shocks will affect it, leading to unsteady results. Conversely, if a slow low pass filter is used - low cut-off frequency, the scale will be less sensitive to transients and unwanted frequency components, but the scale will be slow to display results.

Weighing scales must show reliable results, along with an indication on the stability of the scale. As a result, designers usually use a slow filter to minimise the risk of the scale being unsteady all the time, and therefore being of no use.

The invention is very useful, as it allows the use of fast filters without the risk of the scale being useless if the base is vibrating.

In known systems the signal from the load cell is filtered either through digital or analogue means with a "low pass filter". A low pass filter is attenuating all parts of the signal having a higher frequency than the selected cut-off frequency. By using low pass filtering a steady readout is obtained faster than if no filter is applied as the mechanical system then has to be in rest before a steady readout is available.

The optimal cut-off frequency is typically a function of the weight of the moving parts of the scale, the weight of the item to weight, the mechanical damping characteristics of the scale and the vibrations induced by the surroundings. This means that the scale typically is equipped with more than one cut-off filter in order to be able to work as fast as possible in different environments and with items of varying sizes.

A major problem with these known systems is however that if the vibrations due to placing items on the scale platform vary considerably for instance from one item to another, and/or the vibrations induced by the surroundings also vary, then a single filter with a fixed cut-off frequency will not always yield the fastest possible weighing result and readout of the scale.

The speed of weighing is important, as it is frequently the limiting time factor in a grading process.

The most common method of selecting an optimal filter on weighing instruments is to do it manually. A manual change or selection of filter is in nature quite slow as it involves an operator changing the set-up of the scale. Furthermore it may not be possible to select the most optimal filter manually. As an example the measures induced by the way the items are being arranged on the scale or induced by external conditions, such as heavy traffic

occurring in the weighing area could change instantly, whereby manual setting would not practically be possible.

Description of the Invention

It is an aim of the present invention to provide a method for automatically selecting an optimal low pass filter having the best cut-off frequency such that weighing of items may be performed as fast as possible with a particular scale and so that the scale will always respond to the actual conditions of the weighing.

Accordingly the present invention relates to a method for providing a measure of an item, the method comprising the steps of:

- reading a first signal being responsive to the measure of the item,
- frequently measuring a plurality of values of the signal so as to provide a stream of data,
- repetitively providing output signals from at least two different processing means until an output signal of a first one of the at least two different processing means fulfils a stability requirement, the output signals being based on processing of the stream of data, and
- assigning an output signal from the first one of the at least two different processing means that fulfilled the stability requirement to the measure.

The measure of the item could as an example be the weight of the item, the size of the item, the colour of the item or any other measure of the item. As an example the first signal being responsive to the measure of the item could be an electrical current from an electrical scale, the voltage, the resistance or the current being responsive to the weight of the item. As another example the first signal could be an electrical current provided e.g. by a CCD of a digital camera. In that case the conversion of the signal into a stream of data would typically happen internally in a processor of a digital camera or camcorder.

In a broad aspect, the present method according to the present invention is applicable to any kind of processing of a stream of digital signals being the result of for instance an analogue-to-digital conversion, the analogue signal being the result of some recognition - or measuring - of one or more physical quantity, such as a weight of an item.

In the present content, a digital signal denotes a signal being represented by a stream or a series of digital values, ordered sequentially by time.

In a preferred embodiment of the present invention the stream of digital values (signals) is a substantially constant inflow of digital values to the processing means. The processing means are preferably numerical algorithms executed in a digital processor such as a microcomputer, but hardware processing means may also be used in connection with the present invention.

The processing means, which in general are different, are different in the sense that the processing performed by them are said to vary in degree. By this varying processing degree is meant that for instance the cut-off frequencies of the processing means, in case these are characterised as filters are different. In other cases, the difference may be the way they process the digital signals such as one processing giving a average value and another processing means giving a filtered value (please note that in some case process providing an average value is referred to as a filtering process).

In the broad aspect of the present invention each of the processing means provides an intermediate output signal. These signals are in general different, as they are the results of applying the processing means, which are different, to the stream of digital values. After these intermediate signals are made available by the processing means the method according to the present invention detects the signal being the most appropriate for the time being, i.e. the signal from the fastest filter which fulfils a stability requirement. The most appropriate signal is assigned to be the output signal.

According to a preferred embodiment of the invention the processing means calculates an average value of N last provided data of the stream of data. N could denote the 10, 100 or even 1000 latest provided data. In the case a small number of data is used for the calculation of the average, the processing means would be very fast but on the other hand the output signals from the processing means could be rather fluctuating. If a larger number of data is used, the processing means would be slower but the output signal would typically be more stabile. The number of data N could preferably be selected differently for each of the processing means applied. In that sense the processing means

would have different reaction speed and their output signal would have different characteristics.

The stability requirement to be fulfilled could simply be comparing an output signal of one of the at least two processing means with a reference value. The reference value could be the last output signal of the same processing means or an output signal of one of the other processing means. Accordingly the stability requirement could be a requirement to a maximum difference between two successive output signals of one of the processing means.

Preferably one of the processing means is working in a large domain of data, such as on a set of data including a larger number N of data. The other processing means are then working on smaller sub-set of the N data. If the processing means are processing averages of the data, the one of the processing means that works with the large domain would be relatively slow compared with the other processing means. On the other hand the fluctuation in the output signal of the processing means working in the large domain of data would be relatively low.

As an example the processing means could be provided in the form of digital filters for filtering the stream of data. The digital filter could be low-pass filters running averaging algorithms numerically evaluating the mean values of the stream of data.

Preferably the running averaging algorithms are applied successively; the next algorithm applied is applied based at least partly on the result of the previously applied algorithm.

In case no output signals fulfils the stability requirement, an output signal from the last one, or the slowest one of the processing means could be assigned to the measure. The slowest one of the processing means would in the case of processing averages be the one processing the largest number N of data. If no output signals fulfils the stability requirement, an output signal from one of the "medium speed" processing means may also be selected, e.g. one running averaging with a medium number N of data or actually any one of the processing means may be selected.

Detailed description of the invention

In the following the invention and particular preferred embodiments thereof will be described in greater details with reference to the accompanying figures in which:

Fig. 1 is a schematic drawing of an electronic weighing scale,

Fig. 2 shows a diagrammatic view of the main elements of the method of weighing according to the present invention,

Fig. 3 shows a schematic drawing of a preferred embodiment of the filtering method according to the present invention,

Fig. 4 shows a flow chart of a preferred embodiment of the filtering method according to the present invention.

In fig.1 a typical electronic scale 10 is shown. The scale 10 comprises a base part 20 wherein a load cell 60 is situated, a scale platform 40 on which the item to be weighed is placed and display 50. The scale 10 also comprises a logical unit such as a computer or a micro-controller for transforming the signal coming from the load cell 60 to a readout on the display 50.

In fig. 2 the electronics comprised in the scale 10 are schematically depicted. The actual choice of electronic components is not crucial for the invention as ordinary known electronically components may be used. Referring to fig. 2 the load cell 60 which may comprise a strain gauge acting as a resistor in a Wheatstone bridge circuitry is actuated by for instance a rod connected to the scale platform 40.

The load cell 60 will thereby provide an electrical signal with a magnitude representing the force of the scale platform 40 applied to the load cell 60. This force will in general be different from the weight of the moving part of the scale plus the force due to the weight of the item times the gravity constant until these parts are in rest. This as the movement of the parts involves acceleration of the parts.

The signal coming from the load cell 60 is then directed to an A/D-converter 70 from which a bit pattern representing the actual amplitude of the signal from the load cell is provided at a predetermined sampling rate. The sampling rate and the resolution of the A/D-converter may be determined by the physics of the scale.

The bit pattern is then directed to a micro-controller 80 being able to perform a filtering of the signal. Referring to Fig. 3, the filtering is performed by use of, for instance, five low pass filters having different cut-off frequencies:

The low pass filters can for example be implemented as moving average filters.
A moving average filter calculates the average value from a set of N last digital values in a stream of data. The size of the set N determines the response or behaviour of the filter as well as the sampling rate of the data. If the filter uses many digital values in the calculation then a single new input value will have little effect on the average and the filter will slowly change the result as the input data changes. On the other hand if the filter is calculating average from a few digital values, the average changes quickly if the newest value is changed

The following is an example of filters that may be used in connection with weighing according to the present invention.

Filter A (very fast response – very sensitive to exterior vibrations). The filter has only 1 digital value. The result is:

$$\bar{x}_1 = \frac{newest_digital_value}{1}$$

Filter B (fast weighing). The filter calculates the average of the last 2 digital values in the input stream. The result is:

$$\bar{x}_2 = \frac{newest_digital_value + the_value_before}{2}$$

Filter C (normal weighing).The filter calculates the average of the last 4 digital values in the digital stream.

$$\bar{x}_4 = \frac{value_1 + value_2 + value_3 + value_4}{4}$$

Filter D (slow weighing) The filter calculates the average of the last 8 digital values in the input stream,

$$\bar{x}_8 = \frac{\sum_{i=1}^{8} value_i}{8}$$

Filter E (slowest weighing not sensitive for exterior vibrations) The filter calculates the average value of the last 16 digital values in the input stream,

$$\bar{x}_{16} = \frac{\sum_{i=1}^{16} value_i}{16}$$

The filtering is performed by the following scheme. Each time a value is available at the output of the A/D-converter, this value is directed to the filtering means. The filtering means holds a list of values corresponding to a pre-selected number of earlier measured values. Each filter is activated and determines filtered intermediate filtered values, one for each filter, based on the new value and the old values except the oldest.

For each of the filters applied, the intermediate filtered values are checked for stability, i.e. the most recent determined intermediate value corresponding to a specific filter is compared with the value determined last time the same filter was activated. If the difference between these two successive intermediate values is within a certain limit then the signal filtered with the specific filter is said to be stable.

In many practical applications more than one intermediate value is found to be stable and in that case the intermediate value corresponding to the fastest filter is selected as the output value from the filtering routine. The reasoning behind choosing the value corresponding to the fastest filter is that this choice will provide the earliest stable readout.

According to the general aspect of the present invention a selection of the most appropriate filter is done. Before going into a detailed description of the selection routine

and a preferred embodiment of this and the filters applied, the general structure of the filtering routine is explained with reference to Fig. 3.

The digital weight signal, Input value of Fig. 3, provided by the A/D-converter is filtered with a number of different filters, Filter A, Filter B, Filter C, Filter D and Filter E of Fig. 3. The output from each filter is checked for stability and the least filtered (fastest) steady value is selected. This will give the fastest possible response. Fig. 4 is a flowchart showing the Multi-Filter System principle.

In the following text filter algorithm to be used in connection with the present invention will be introduced. The features of the method according to the present invention may in general be described by the following item list:

- There are several low-pass filters running at the same time.
- The invention deals with the selection of the filters in real time
- The lowpass filters have different corner frequencies, but their exact implementation is not important.
- The software selects in real time the fastest steady filter.
- If no filter gives a steady result one of the medium ones is normally selected.

The method according to the present invention works in the following way, when considering different situations:

Steady vibrations attack the base of the scale:

- Only some of the slowest filters will produce steady results, and for each item being weighed, the filter producing a steady result fastest, will be used.
- The scale will work accurately, but will be slow.

Vibrations occur when an object is placed on the platform and stop when the mechanical structure becomes stable:

- A signal will be formed when the object it put on the platform but it will have unwanted frequency components because of the vibration.
- The results from all filters are monitored and the result from the first filter to show a steady result will be used.

- Which filter will be the first filter to give a steady result depends on the system character and the vibrations,
- In a well-designed system, the fastest filter would be the first to become stable if no vibration exists in the base.

Transient shocks on the base:

- In this case the fastest filters will give unsteady result, and the software will look for a slower filter still not affected by the shock.
- The displayed result remains steady until the slowest filter gives an unsteady result. This gives the scale the stability of the slowest filter.

Steady calculation:

One way of detecting a steady result from a filter is to calculate the difference between the last two results and compare it to a predetermined small value. If the difference is greater than the value, the filter result is not stable. The time between any two results is normally constant, for example 50 or 100 milliseconds.

It is also possible to use a change in the final displayed result (weight) as an indication of a steady result. This can be an advantage in weighing scales where the displayed weight must be rounded in certain way to comply with "General Weights and Measures" regulations. The method can give better results but requires more processing power.

Fig. 4 shows a flowchart describing the invention.

Following method according to the present invention is described with reference to a program which, when launched in a computer will perform the selection of the optimal filter. The program is described in Pascal like language and comprises the following statements:

The first 17 lines are comments.

```
*     FilterA   A variable that holds the result of a FilterA   (very fast response)
*     FilterB   A variable that holds the result of a FilterB   (fast response)
*     FilterC   A variable that holds the result of a FilterC   (normal response)
*     FilterD   A variable that holds the result of a FilterD   (slow response)
*     FilterE   A variable that holds the result of a FilterE   (slowest response)
*
*     Filter_A_steady   A flag that is true if FilterA gives a steady result
*     Filter_B_steady   A flag that is true if FilterB gives a steady result
*     Filter_C_steady   A flag that is true if FilterC gives a steady result
*     Filter_D_steady   A flag that is true if FilterD gives a steady result
*     Filter_E_steady   A flag that is true if FilterE gives a steady result
*     Optimal_Result    A variable that holds the selected, optimal result
*
*
*
*   The following is the program describing the invention
*
Repeat
      Get_new_ADvalue ;                    * Get a new value from the A/D converter
      Calculate_new_results ;              * All filters are recalculated
      Optimal_Result  := FilterC ;         * Use normal response filter if no filter is
stable
      If Filter_E_steady THEN Optimal_Result:= FilterE ;
      If Filter_D_steady THEN Optimal_Result:= FilterD ;
      If Filter_C_steady THEN Optimal_Result:= FilterC ;
      If Filter_B_steady THEN Optimal_Result:= FilterB ;
      If Filter_A_steady THEN Optimal_Result:= FilterA ;
      Display(Optimal_Result) ;            * Display the result from the fastest steady
filter
until false
```

CLAIMS

1. A method for providing a measure of an item the method comprising the steps of:

- reading a first signal being responsive to the measure of the item, the first signal comprising a stream of data,
- repetitively providing output signals from at least two different processing means until an output signal of a first one of the at least two different processing means fulfils a stability requirement, the output signals being based on processing of the stream of data, and
- assigning an output signal from the first one of the at least two different processing means that fulfilled the stability requirement to the measure.

2. A method according to claim 1 wherein the first signal is measured as a signal and wherein a plurality of values of the signal frequently is being measured so as to provide a stream of data.

3. A method according to claim 1 or 2, wherein the processing comprises calculating an average value of N last provided data of the stream of data.

4. A method according to any of the preceding claims, wherein each of the at least two different processing means processes an average value of a number of last provided data of the stream of data N and wherein N is a different number for each of the processing means.

5. A method according to any of the preceding claims, wherein the stability requirement to be fulfilled comprises comparing an output signal of one of the at least two processing means with a reference value.

6. A method according to any of the preceding claims, wherein the stability requirement to be fulfilled comprises a requirement to a maximum difference between two successive output signals of one of the at least two processing means.

7. A method according to any of the preceding claims, wherein a first set of data comprising a number N of data from the stream of data is processed by one of the at least

two different processing means and wherein the remaining processing means are processing sub-sets of the first set of data.

8. A method according to any of the preceding claims, wherein the first signal is an electrical current provided by an instrument .

9. A method according to claim 8, wherein the electrical current is converted into a stream of digital data by means of an A/D converter.

10. A method according to any of the preceding claims, wherein the first signal is representing responses to weighing of an item on a weighing scale.

11. A method according to any of the preceding claims, wherein the processing means comprise(s) digital filters for filtering the stream of data.

12. A method according to claim 11, wherein the digital filters comprise low-pass filters.

13. A method according to claim 12, wherein the low-pass filters are running averaging algorithms numerically evaluating the mean values of the stream of data.

14. A method according to claim 13, wherein the sets of measured data to be used in the running averaging algorithms are series of numbers 2, 4, 8, 16 numbers of values of the stream of data.

15. A method according to claim 13 or 14, wherein the running averaging algorithms are applied successively; the next algorithm applied is applied based at least partly on the result of the previously applied algorithm.

16. A method according to any of the preceding claims, wherein an output signal from the last one of the at least two different processing means is being assigned to the measure in case no output signal fulfils the stability requirement.

17. A method according to any of the preceding claims, wherein an output signal from a processing means with a medium processing speed is being assigned to the measure in case no output signal fulfils the stability requirement.

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(54) Title: MULTI-FILTER

(57) Abstract: The present invention relates to a method for weighing items and in particular to a method of filtering signals representing the weight of an item. The invention is applicable in all measuring instruments which indicate an average value calculated from a signal which also has unwanted components of one or more unknown frequencies. This is, for example, the case in voltmeters, ampere meters and weighing-scales. Normally, the indicated result is the average value of the signal measured for a much longer time than the expected period of the slowest frequency component. This method is well known and reliable, but has the drawback of being very slow in situations where measuring speed is of importance.

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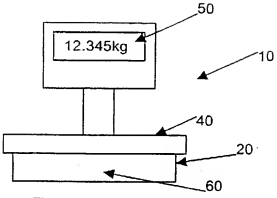

Fig. 1

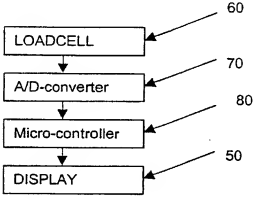

FIG 2

FilterA has very fast response
FilterB has fast response
FilterC has normal response
FilterD has slow response
FilterE has slowest response

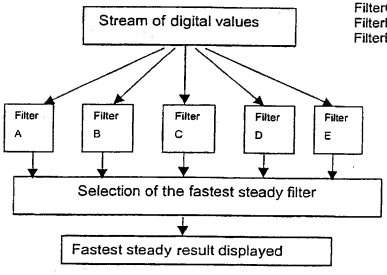

Figure 3

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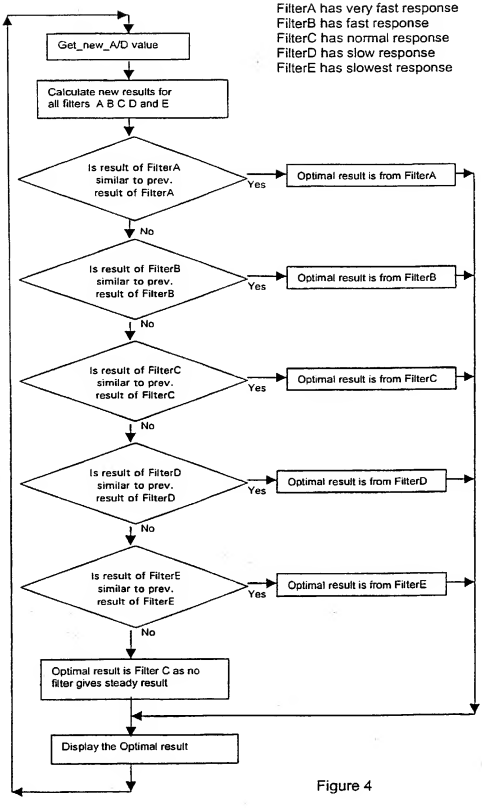

Figure 4

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FORM

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the specification of which (CHECK applicable BOX(ES))

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- A. ☐ is attached hereto.
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PRIOR FOREIGN APPLICATION(S) Number	Country	Day/Month/Year Filed	Date first Laid-open or Published	Date Patented or Granted	Priority NOT Claimed
IS00/00010	PCT	02 OCTOBER 2000			
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And I hereby appoint Pillsbury Winthrop LLP, Intellectual Property Group, 1600 Tysons Boulevard, McLean, VA 22102, telephone number (703) 905-2000 (to whom all communications are to be directed), and the below-named persons (of the same address) individually and collectively my attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith and with the resulting patent, and I hereby authorize them to delete names/numbers below of persons no longer with their firm and to add and rely on instructions from and communicate directly with the person/assignee/attorney/firm/ organization who/which first sends/sent this case to them and by whom/which I hereby declare that I have consented after full disclosure to be represented unless/until I instruct the above Firm and/or a below attorney in writing to the contrary.

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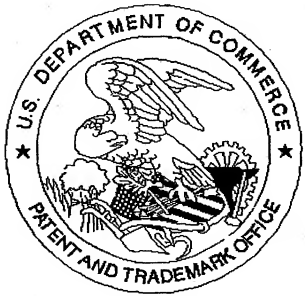

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